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Eureka Reservoir
Dam and Dikes,
Choteau, Montana,
Main Dam-MT-1354,
West Dike-MT-1342

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

EUREKA RESERVOIR DAM AND DIKES
CHOTEAU, MONTANA
MAIN DAM—MT-1354
WEST DIKE—MT-1342

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PREPARED FOR:

HONORABLE THOMAS L. JUDGE
GOVERNOR, STATE OF MONTANA

TETON COOPERATIVE CANAL COMPANY
(OWNER AND OPERATOR)

PREPARED BY:
CH2M HILL
BELLEVUE, WASHINGTON
NOVEMBER 1980

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Phase 1 Inspection Report

National Dam Safety Program

EUREKA RESERVOIR DAM AND DIKES
Choteau, Montana

Main Dam--MT-1354
West Dike--MT-1342

Prepared For:
Honorable Thomas L. Judge
Governor, State of Montana

Teton Cooperative Canal Company
(Owner/Operator)

Prepared By:
CH2M HILL
Bellevue, Washington

November 1980

SEATTLE DISTRICT
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EXECUTIVE SUMMARY

Under contract with the Seattle District Corps of Engineers and with representation from the Corps, the State of Montana Department of Natural Resources and Conservation (DNRC), and the Teton Cooperative Canal Company, CH2M HILL inspected Eureka Reservoir Dams on October 31, 1979, under the authority of Public Law 92-367. The project is located in a small basin adjacent to the Teton River about 7 miles northeast of Choteau, Montana.

This report was compiled from information obtained during an onsite inspection and analysis of available hydrologic information. Findings were compared with engineering criteria that are currently accepted by most private and public agencies engaged in dam design, construction, and operation.

FINDINGS AND EVALUATION

Eureka Reservoir Dam and Dikes are owned and operated by the Teton Cooperative Canal Company. The reservoir is used for storage of irrigation waters but also receives some recreational use.

The project, consisting of the 31-foot-high main dam, the 12-foot-high West Dike, and the 4-foot-high East Dike, impounds approximately 6,200 acre-feet of water at top of West Dike, assumed elevation 4133.7 feet National Geodetic Vertical Datum (NGVD). On the basis of criteria in U.S. Army Corps of Engineers Recommended Guidelines for Safety Inspection of Dams (Ref. 1), the project is intermediate in size. The main dam and West Dike are located such that their failures could endanger lives and cause extensive property damage. Approximately ten homes along the 7 miles of the Teton River between the project and Choteau could be affected by a rapid failure of either structure. Also, some flooding could occur in Choteau. No dam breach analysis or routing of a dam breach flood was made for the downstream area; therefore, the conclusions on probable damage are based on a brief field visit and engineering judgment. The project is classified as having a high (Category 1) downstream hazard potential. Inspection criteria (Ref. 1) recommend that an intermediate-sized project with a high downstream hazard potential be capable of safely handling the probable maximum flood (PMF). The PMF is the flood expected from the most severe combination of meteorologic and hydrologic conditions that are reasonably possible in the region.

An estimated PMF was developed for the 1.8-square-mile drainage basin. The PMF resulting from the 72-hour storm has an estimated volume of 1,780 acre-feet. The project has no

designed spillway; however, low areas on either side of the main dam would carry flow before the dam or dikes overtopped. It was estimated that 4,400 c.f.s. could pass over the low areas before the West Dike is overtopped. The PMF routing was started with the reservoir near the level of the low areas. Routing of the flood showed that the project can control the estimated PMF without overtopping the dam or dikes. However, detailed field survey information of the overflow areas is required to verify this finding. In addition, flow passing over the low areas around the ends of the dam during extreme floods could cause minor erosion of embankment material.

The outlet works conduit and wet well control tower were not inspected during the field visit.

RECOMMENDATIONS

A downstream warning system, for use in the event of impending dam failure, should be developed and immediately placed in action. Inspect the outlet works conduit and wet well tower and repair as necessary. Conduct more detailed hydrologic and hydraulic routing studies to better determine the downstream hazard and required spillway capacities. Studies should also determine the flow capacity of the low areas. Modify the project as studies indicate. Provide erosion protection in low overflow areas. Restore the main dam upstream slope to the design section. Conduct seepage and stability analyses of the dam and West Dike embankment and modify the sections as required to conform with the recommended guidelines.

Conduct periodic inspections of the project at least every 5 years by geotechnical engineers experienced in dam design and construction.

Before implementing report recommendations, coordinate the work with the State of Montana DNRC to ensure compliance with all pertinent laws and regulations.

RICHARD L.
FOSTER
2646 E

Richard L. Foster
Professional Engineer

PERTINENT DATA

1. GENERAL

Federal ID Nos.	
Main Dam	MT-1354
West Dike	MT-1342
Owner/Operator	Teton Cooperative Canal Company
Date Constructed	1936
Purpose	Irrigation
Location	Sections 25 and 36 of T25N, R6W Sections 31 and 32 of T25N, R5W Principal Meridian
County, State	Teton County, Montana
Watershed	Tributary of Teton River
Downstream Hazard Potential	Category 1 (High)
USGS Quadrangle	Bynum

2. RESERVOIR

Surface Area at Overflow (Low Area), Elevation 4131.9 feet NGVD	390 acres
Storage at Overflow, Elevation 4131.9 feet NGVD	5,500 acre-feet
Storage at West Dike Crest, Elevation 4133.7 feet NGVD	6,200 acre-feet
Pool Elevation on Date of inspection	1420.9 feet NGVD

NOTE: All elevations are based on an assumed elevation of 4135 feet NGVD for the crest of the main dam.

Surcharge Storage	700 acre-feet
Drainage Area	1.8 square miles

3. OUTLET WORKS

Control Tower	60-inch-diameter wet well
Conduit	36-inch-diameter CMP
Conduit Length	200 feet
Gate	36-inch-diameter slide gate in wet well

Capacity with Reservoir at Overflow, Elevation 4131.9 feet NGVD	110 c.f.s.

4. OVERFLOW AREAS

Type	Low areas at both abutments of main dam will carry flow during high reservoir levels.
Length	800 feet (approximately)
Elevation	4131.9 feet NGVD
Estimated Capacity with Reservoir at West Dike, Crest Elevation 4133.7 feet NGVD	4,400 c.f.s.

5. MAIN DAM (MT-1354)

Type	Earth
Length	1,800 feet
Crest Width	15 feet
Crest Elevation	4135 feet NGVD
Hydraulic Height (crest to toe)	31 feet
Upstream Slope	1 V on 3 H
Downstream Slope	1 V on 2 H
Downstream Potential Hazard	High

6. WEST DIKE (MT-1342)

Type	Earth
Length	1,000 feet
Crest Width	10 feet
Crest Elevation	4133.7 feet NGVD
Hydraulic Height (crest to toe)	12 feet
Upstream Slope	1 V on 2 H
Downstream Slope	1 V on 2 H
Downstream Potential Hazard	High

7. EAST DIKE (too small for the National Dam Inventory)

Type	Earth
Length	400 feet
Crest Width	10 feet
Crest Elevation	4133.9 feet NGVD
Hydraulic Height (crest to toe)	4 feet
Upstream Slope	1 V on 2 H
Downstream Slope	1 V on 2 H

Chapter 1
BACKGROUND

1.1 INTRODUCTION

1.1.1 Authority and Scope

This report summarizes the Phase I inspection and evaluation of the Eureka Reservoir Dam, owned by the Teton Cooperative Canal Company.

The National Dam Inspection Act, Public Law 92-367, dated August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to conduct safety inspections of non-Federal dams throughout the United States. Pursuant to that authority, the Chief of Engineers issued "Recommended Guidelines for Safety Inspection of Dams" in Appendix D, Volume 1 of the U.S. Army Corps of Engineers' report to the United States Congress on "National Program of Inspection of Dams" in May 1975.

The recommended guidelines were prepared with the help of engineers and scientists highly experienced in dam safety from many Federal and state agencies, professional engineering organizations, and private engineering consulting firms. Consequently, the evaluation criteria presented in the guidelines represent the comprehensive consensus of the engineering community.

Where necessary, the guidelines recommend a two-phased study procedure for investigation and evaluation of existing dam conditions, so deficiencies and hazardous conditions can be readily identified and corrected. The Phase I study is:

(1) a limited investigation to assess the general safety condition of the dam.

(2) based upon an evaluation of the available data and a visual inspection.

(3) performed to determine if any needed emergency measures and/or if additional studies, investigations, and analyses are necessary or warranted.

(4) not intended to include extensive explorations and analyses or to provide detailed alternative correction recommendations.

The Phase II investigation includes all additional studies necessary to evaluate the safety of the dam. Included in Phase II, as required, should be additional visual inspections,

measurements, foundation exploration and testing, material testing, hydraulic and hydrologic analyses, and structural stability analyses.

The authority for the Corps of Engineers to participate in the inspection of non-federally owned dams is limited to Phase I investigations, with the exception of situations of extreme emergency. In these cases, the Corps may proceed with Phase II studies but only to the extent needed to answer questions relating to dam safety that cannot be answered otherwise. The two phases of investigation outlined above are intended only to evaluate project safety and do not encompass in scope the engineering required to perform design or corrective modification work. Recommendations contained in this report may be for either Phase II safety analyses or detailed design study for corrective work.

The responsibility for implementation of these Phase I recommendations rests with the dam owner and the State of Montana. It should be noted that nothing contained in the National Dam Inspection Act, and no action or failure to act under this Act shall be construed (1) to create liability in the United States or its officers or employees for the recovery of damage caused by such action or failure to act or (2) to relieve an owner or operator of a dam of the legal duties, obligations, or liabilities incident to the ownership or operation of the dam.

1.1.2 Purpose

The purpose of the inspection and evaluation is to identify conditions that threaten public safety, so that they may be corrected in a timely manner by non-Federal interests.

1.1.3 Inspection

The findings and recommendations in this report are based on a brief visual inspection of the project and a detailed review of available construction plans. Inspection procedures and criteria are those established by the Recommended Guidelines for Safety Inspection of Dams (Ref. 1).

Personnel present during the inspection included:

Richard Eckerlin, Geologist, Seattle District Corps of Engineers
Art Taylor, State of Montana, Department of Natural Resources and Conservation
Jim Carlson, Teton Cooperative Canal Co.
Charles Crane, Teton Cooperative Canal Co.
Herb Tangen, Teton Cooperative Canal Co.

CH2M HILL personnel who participated in the field inspection and/or contributed to this report are:

Miles Bubenik, Geotechnical Engineer, Team Leader
Jerry Jacksha, Geotechnical Engineer
Loren Bottorff, Hydrologist/Hydraulics Engineer

This report has been reviewed by representatives of the owners, and the State of Montana DNRC. Their written comments are enclosed in the Appendix of this report.

1.2 DESCRIPTION OF PROJECT

1.2.1 General

Eureka Reservoir is located in a small basin adjacent to the Teton River in Teton County, Montana. The project is approximately 7 miles northwest of Choteau (see Plate 1). The project has a high (Category 1) downstream hazard potential. The Federal identification numbers for the dam and West Dike are MT-1354 and MT-1342, respectively. East Dike is only 4 feet high and does not have a Federal identification number. The project was constructed in about 1936. The reservoir is an off-channel storage for irrigation water and is filled by canal diversion from the Teton River. The project is owned and operated by Teton Cooperative Canal Company. The reservoir receives some recreational use.

Eureka Reservoir Dam is 31 feet high and 1,800 feet long; the West Dike is 12 feet high and 1,000 feet long; and the East Dike is 4 feet high and 400 feet long. The structures impound approximately 6,200 acre-feet at West Dike crest elevation 4133.7 feet NGVD. (All elevations are based on an elevation of 4135 for the crest of the main dam.) The crest elevation of East Dike is 4133.9 feet NGVD.

The low-level outlet for the dam consists of a 36-inch-diameter corrugated metal pipe (CMP) controlled by a 36-inch-diameter slide gate. The slide gate is located in a 60-inch-diameter CMP wet well that will act as a drop inlet at high reservoir levels. The project has no designed spillway; however, low areas at either abutment of the main dam will act as spillways for the project. These low areas are about 1.8 feet lower than the crest of the West Dike and 3.1 feet lower than the crest of the Main Dam.

Based on our visual reconnaissance and engineering judgment, approximately ten homes along the Teton River between the project and Choteau could be affected by a sudden breach of the dam or the West Dike. Some flooding may occur in Choteau. On the basis of this information and in accordance with the recommended guidelines, the project size is intermediate, and the downstream hazard potential is high (Category 1).

1.2.2 Regional Geology and Seismicity

The regional geology and seismicity were addressed in a memorandum by R. D. Eckerlin (Ref. 2). The following information is based on parts of that memorandum.

Eureka Reservoir lies in the Great Plains physiographic province, a region of subdued knob and kettle topography left by the stagnating glaciers that once occupied the region. The area is underlain by the Cretaceous Virgelle Sandstone Formation and soft shale (claystone) and cross-bedded sandstone of the overlying Two Medicine Formation. The Virgelle Sandstone Member is composed of fine- to medium-grained arkosic sandstone and is the most widespread unit in the area around Eureka Reservoir. The bedrock units dip gently west off the west flank of the South Arch segment of the Sweetgrass Arch.

Eureka Reservoir lies in an area of moderate seismic activity. The Inspection Guidelines Zoning Map shows the site in Zone 2, which has a potential for moderate earthquake damage. Although the zoning map is based on a known distribution of damaging earthquakes, it does not necessarily reflect accurate or adequate seismic design for the site. The closest historic seismicity was a magnitude 3.0 event, which occurred in 1935 about 8 miles north of the dam. Western Montana is seismically active along the Rocky Mountain Front. This area shows the greatest chance of producing the highest acceleration Eureka Reservoir Dam would experience. The seismicity east of the front is quite diffuse, and there is no lineup of epicenters which indicate Eureka Reservoir Dam to be in a high risk area. Algermissen (1976) estimates a 90 percent chance of a 0.04g acceleration being felt at this dam in a 50-year period.

1.2.3 Site Geology

The site geology also was addressed in the R. D. Eckerlin memorandum (Ref. 2). The following information is based on parts of that memorandum.

There are no known pre- or post-construction geotechnical investigations and no data are available on foundation preparation or treatment. The dam appears to be founded on alpine (mountain) glacial outwash and Cretaceous Virgelle Sandstone. Outwash in the area consists of unsorted materials containing clay, silt, sand, gravels, and boulders to 7 feet in diameter.

In the area of the low-level outlet, sandstone is also exposed in the floor and sides of the stilling basin. The sandstone is thinly bedded and is lying almost horizontally.

The East Dike is founded on glacial outwash and eolian silt and sand. The borrow area for this dike appears to be in the reservoir area a few feet beyond the upstream face. The West Dike is presumed to be founded on outwash deposits.

1.2.4 Design and Construction History

The Eureka Reservoir project was formerly called Burton Reservoir Dam and is owned by the Teton Cooperative Canal Company (TCCC). In 1936 the dam was designed and constructed by the Montana State Water Conservation Board. In 1975 the State of Montana DNRC assisted TCCC with a study to upgrade and repair the canal system from Eureka Reservoir (Ref. 3). Because of high costs, development of the canal system was not undertaken.

Chapter 2
INSPECTION AND RECORDS EVALUATION

2.1 HYDRAULICS AND STRUCTURES

2.1.1 Outlet

The low-level outlet for Eureka Reservoir is located through the embankment of the Main Dam. The outlet consists of a 36-inch-diameter corrugated metal pipe (CMP) controlled by a 36-inch-diameter slide gate. The gate is located in a 60-inch-diameter CMP wet well control tower about 20 feet upstream of the dam axis (Photo 5). During the site visit, the outlet works conduit and wet well tower were not inspected.

The 36-inch-diameter CMP conduit extends about 85 feet from the intake structure to the 60-inch-diameter CMP wet well. The top of the wet well is at assumed elevation 4131.6 feet NGVD; 3.4 feet lower than the crest of the dam and 0.3 feet lower than the low areas (see paragraph 2.1.2) at the ends of the dam. The hand crank control is located at the top of the CMP wet well. The control is exposed to the weather but is operable and appears to be in good condition. The control is reached by a single wooden plank walkway. The walkway could become submerged at high reservoir levels, making operation of the gate very difficult. The wet well is open at the top, so it will act as a drop inlet at high reservoir levels. However, it will not act as a spillway for the reservoir unless the gate is intentionally opened because the gate is on the downstream side of the wet well. The 36-inch-diameter CMP conduit extends about 90 feet from the wet well to the downstream toe of the dam. The conduit discharges directly to a shallow pond that contains broken concrete riprap (Photo 6). The discharges are not eroding or backcutting the embankment toe. Another culvert drains the water from the pond to the downstream channel.

The discharge rating of outlet works was developed by assuming that the gate was fully open. The conduit was assumed to flow full with Manning's "n" of 0.024. The discharge capacity of the outlet works with the reservoir at the top of the wet well was estimated to be 110 c.f.s.

2.1.2 Overflow Areas

Low areas, located on each abutment of the dam, form natural spillways through which flood waters could be discharged. The area at the right abutment of the dam can be seen in Photos 1, 2, and 3; the pickup truck is in the low area, and the dam embankment is to the right of the truck. The low areas are about at elevation 4131.9 feet NGVD, about 3.1 feet lower than the low point on the dam, and about 0.3 feet higher than the top of the outlet works wet well tower. The

low area at the right abutment is about 600 feet long, and the area at the left abutment is about 200 feet long. The flow passing these areas could cause erosion of the dam embankment at the abutment contact. Although erosion may not immediately affect dam safety, adequate protection is required to control it.

The discharge rating of these areas was estimated by assuming that the areas act as broad-crested weirs with a discharge coefficient of 2.65. The coefficient was reduced to 2.3 to account for the chance of submergence because of the flat area downstream. The maximum discharge of these areas was estimated to be 4,400 c.f.s., with the reservoir at West Dike, crest elevation 4133.7 feet. This estimate is based on observations made during a brief field visit and needs to be verified using data from a detailed field survey. The estimated discharge rating of the overflow areas is presented on Plate 3.

2.1.3 Freeboard

Flood routing estimates (see paragraph 2.2.4) indicate that the project can just control the PMF without overtopping the dam or dike; however, these are rough estimates because of the lack of detailed data. The vertical distance between the crest of the West Dike, East Dike, and dam and the reservoir level at the time of the October 31, 1979, inspection was 13 feet, 13.2 feet, and 14.1 feet, respectively. The overflow areas at the abutments of the dam are about 1.8 feet below the crest of the West Dike. The reservoir is normally filled to a level about 3 feet below (corresponds to high water mark) the overflow areas, elevation 4129 feet NGVD, leaving a normal freeboard of 4.7 feet on the West Dike, 4.9 feet on the East Dike, and 6 feet on the dam. The effective fetch for wind-generated waves on the reservoir is about 0.5 mile for the West Dike, with wave runup estimated to be about 3 feet. The wave runup on the East Dike and on the dam is expected to be less than 3 feet. The vertical distances between the normal maximum reservoir level and the crests of the dam and dikes are adequate to prevent overtopping the embankments by wind-generated waves.

2.2 HYDROLOGY, CLIMATOLOGY, AND PHYSIOGRAPHY

2.2.1 General

The climate of the area is continental in nature, characterized by warm summers and cold winters. The nearest (with long record) climatological station (elevation 3945) is at Choteau, about 7 miles southeast of the project. Mean annual precipitation at the station is 12.1 inches with 57 percent falling from May through July. Mean January precipitation is 0.32 inches, and mean July precipitation is

3.26 inches. Mean annual precipitation on the Eureka Reservoir drainage basin may be near 14 inches. Mean annual temperature at Choteau is 43.7 degrees Fahrenheit (F); mean January temperature is 21.1 degrees F; and mean July temperature is 66.3 degrees F. Temperatures on the Eureka Reservoir drainage basin may average about the same as Choteau. Summer temperatures can exceed 100 degrees F, and winter temperatures can dip well below 0 degrees F. Winters have few extended cold spells. Periods of warm, windy "chinook" weather occur between cold spells.

The natural drainage basin area for Eureka Reservoir Dams is 1.8 square miles, consisting of 0.6 square miles of reservoir area and 1.2 square miles of land area. Basin elevations vary from 4130 feet at the reservoir to 4300 feet on the northeast side of the basin. The basin is oval shaped with the reservoir running most of the length of the basin. The land portion of the basin consists of rolling grassland. The reservoir is an off-channel storage for irrigation water and is filled by canal diversion from the Teton River. There are no stream gages on any small creeks in the area. A parshall flume is located on the outlet channel about 500 feet downstream from the dam.

2.2.2 Reservoir Storage and Discharge

The reservoir has a surface area of 390 acres and a storage of 5,500 acre-feet at low area overflow elevation 4131.9 feet NGVD. Approximately 700 acre-feet of surcharge storage is available in the reservoir between the low area and the crest of the West Dike. A rough estimate indicated that the low areas could pass about 4,400 c.f.s. with the reservoir at the crest of the West Dike.

2.2.3 Estimated Probable Maximum Flood

The probable maximum flood (PMF) is the flood expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. An estimate of the PMF was made during this dam safety analysis and was routed through the reservoir.

The procedure contained in the U.S. Weather Bureau's Technical Paper 38 (Ref. 4) was used to compute the probable maximum precipitation (PMP). This storm produces 6.1 inches in 6 hours and 16.1 inches in 24 hours. The 72-hour precipitation was estimated to be 18.5 inches. Frozen ground and zero infiltration losses were assumed for the entire flood. A base flow of 200 c.f.s.(actual value not available for this study) was used to account for canal inflow to the reservoir. This estimate of the PMP produced a flood with a volume of 2,980 acre-feet, or 1,780 acre-feet without canal inflow.

2.2.4 Flood Routing

Because of the small drainage basin and the large percentage of the drainage basin that the reservoir covers, runoff from a given precipitation period was assumed to occur within that period. The actual time of concentration is just a few minutes for most of the basin so this assumption is of little difference than the actual timing of runoff. Hand calculations were used for the flood routing. These estimates indicate that the project can handle the PMF without overtopping the dam or dikes. This is based on rough estimates of overflow area and canal inflow and should be verified by more detailed studies. Minor erosion of the main dam embankment at the abutment contacts may occur as flow passes ends of the dam.

2.3 GEOTECHNICAL EVALUATION

2.3.1 Dam and Dike Embankments

The 31-foot-high earthfill dam has a crest width of about 15 feet and is about 1,000 feet long. Available information is limited to sketches of the embankment section and outlet works (Plate 4). No design, construction control, foundation investigation, preparation or treatment information is available. The upstream design slope is 1 vertical on 3 horizontal. Erosion from wave attack has flattened the upstream slope and removed fine material, leaving well-washed large-sized gravels, as shown in Photo 5. Above the flattened slope, which is about 1 V on 6 H, 6 feet of well-graded gravel on a steepened slope are exposed.

The downstream slope is 1 V on 2 H, and it is uniform with no slumps or cracks. The embankment appears to be a homogeneous gravel section with no internal drain.

The East Dike is 4 feet high, 400 feet long, with a crest width of about 10 feet and slopes of about 1 V on 2 H. The embankment material appears to be a silty clay. Crest elevation of the dike is 4133.9 feet NGVD, 1.1 feet below the dam crest.

The West Dike is about 12 feet high, 1,000 feet long, with a crest width of about 10 feet. Both upstream and downstream slopes are 1 V on 2 H. The embankment is believed to be a homogeneous gravel section. The embankment has a heavy cover of trees and brush. No slumps or cracks were found, although the trees and brush made inspection difficult.

Materials for the construction in 1936 were obtained from the areas adjacent to the Teton River.

2.3.2 Foundation Conditions, Seepage and Drainage

Foundation conditions at the dikes and dam are unknown. If explorations were performed, the information is no longer available. The reservoir level at the time of the inspection (October 21, 1979) was 14.1 feet below the dam crest, and no toe seepage was observed. However, the area along the downstream toe of both the West Dike and dam show evidence of seepage in that a heavy growth of cattail is growing in the immediate downstream area. Neither the dam nor the dikes incorporate any known type of internal drainage.

2.3.3 Stability

No stability analyses for the project are on file as is required for high hazard structures.

The high-strength gravel embankment materials observed in the exposed slopes of both the dam and west dike suggest that if the entire embankments are constructed of similar material, and foundation materials are equally competent, then stability may conform with recommended guidelines. Because information on foundation conditions, foundation preparation, embankment materials, and water levels in the embankments are unavailable, an evaluation of the stability is not possible.

2.4 PROJECT OPERATION AND MAINTENANCE

2.4.1 Dam

Eureka Reservoir Dams are owned and operated by the Teton Cooperative Canal Company. There is no formal operation and maintenance program for the facility. Information on operation and maintenance was obtained through discussions with owner representatives.

Maintenance of the dam and dikes is performed as required. The dam and dikes appeared to require maintenance, in that trees should be removed and the upstream slope on the dam reestablished.

2.4.2 Reservoir

The reservoir is used for storage of irrigation water. Water is diverted to the reservoir by canal from the Teton River. The reservoir is usually filled in the spring and water is released as needed for irrigation. The reservoir is usually filled to a level about 3 feet below the overflow areas, elevation 4128.9 feet NGVD.

2.4.3 Warning System

There is no formal warning plan for use in the event of impending dam failure.

Chapter 3
FINDINGS AND RECOMMENDATIONS

3.1 FINDINGS

Visual inspection of the dams, supplemented by analysis of the project in terms of the recommended guidelines performance standards, resulted in the following findings.

3.1.1 Size, Hazard Classification, and Safety Evaluation

In accordance with inspection guidelines, Eureka Reservoir Project is intermediate in size with a high downstream hazard potential rating. The guidelines recommend that a dam with the above classification be capable of safely handling the PMF. Flood routing estimates indicate the project may handle the PMF without overtopping the dam or dikes. The dam embankment may conform with the recommended guidelines with respect to structural stability; however, there is insufficient information on foundation conditions, embankment materials, and water levels during high reservoir pool on which to make adequate evaluations.

3.1.2. Embankment Dam and Dikes

The upstream slope of the main dam has been severely eroded by wave attack from the design 1 V on 3 H slope to a near vertical slope that is 6 feet high, below which the slope is about 1 V on 6 H.

The area downstream of the main dam shows evidence of seepage throughout the entire dam length.

No slumps, depressions, or cracks were found in the main dam crest or downstream slope.

Based upon findings of the field inspection, the main dam embankment may be a homogeneous gravel section.

The main dam has no known internal drainage.

No piezometers are installed in the dam or dikes.

The 12-foot-high West Dike supports a heavy growth of trees and brush, making inspection difficult. The toe area of the West Dike shows evidence of seepage. The East Dike is only 4 feet high and, therefore, is freeboard protection only and is adequate for that purpose.

In our judgment, the dam and dikes may conform with criteria in the recommended guidelines with respect to stability.

However, information on materials and water levels in the embankments is unavailable and evaluation of stability is not possible.

Levels conducted during the field inspection found that the West and East Dikes were about 1 foot lower in elevation than the main dam.

3.1.3 Discharge and Reservoir Capacity

The reservoir has a surface area of 390 acres and a storage of 5,500 acre-feet at low area overflow elevation 4131.9 feet NGVD. Approximately 700 acre-feet of surcharge storage is available in the reservoir between the low area and the crest of the West Dike. It was estimated that the low areas could pass about 4,400 c.f.s. with the reservoir at the crest of the West Dike. However, this rating needs to be verified by using data from detailed field surveys.

3.1.4 Outlet Works

The outlet works conduit and wet well control tower were not inspected. The wooden plank walkway could be submerged during high reservoir levels, which would make operation of the outlet gate very difficult.

3.1.5 Operation and Maintenance

There is no formal operation and maintenance plan for Eureka Reservoir Dams. Maintenance is performed as required, and the dam and dikes appeared to be well maintained. The reservoir is filled by canal diversion, and releases are made as needed for irrigation. The reservoir is usually filled to a level about 3 feet below the low areas at the abutments of the main dam. There is no formal warning plan for use in the event of impending dam failure.

3.2 RECOMMENDATIONS

The findings suggest that a high priority be given to the following recommendations:

1. Immediately develop, implement, and periodically check an emergency plan for alerting downstream residents in case of impending dam failure.
2. Restore the upstream slope of the main dam to the design section.
3. Inspect the outlet conduit and wet well control tower and repair as necessary.

4. Provide riprap protection at the abutment contacts of the main dam so flow over the low areas will not erode the embankment.

5. Remove all brush, trees, and roots systems from the main dam and West Dike and adequately backfill and compact resulting holes.

6. Conduct more detailed hydrologic and hydraulic routing studies to better determine the downstream hazard and required spillway capacities. Studies should determine the flow capacity of the low areas and evaluate their ability to safely pass high flows. Modify the project as studies indicate.

7. Investigate the dam and West Dike foundation and embankment, conduct laboratory tests, install piezometers and determine water levels in the dam embankment, and conduct seepage and stability analyses. This study must be performed by qualified and experienced geotechnical engineers. Modify the embankments as studies indicate.

8. Periodic inspections of the facility should be conducted at least at 5-year intervals by engineers with experience in dam design and construction.

Before implementing report recommendations, coordinate the work with the State of Montana DNRC to ensure compliance with all pertinent laws and regulations.

REFERENCES

1. U.S. Army Corps of Engineers, Office of the Chief of Engineers Report to the U.S. Congress, National Program of Inspection of Dams, Vol. 1, Appendix D, "Recommended Guidelines for Safety Inspection of Dams," Washington, D.C., Department of the Army, May 1975.

2. Richard D. Eckerlin, U.S. Army Corps of Engineers, "Memorandum on Eureka Reservoir Dam Geology Inspection," February 1980.

3. Department of Natural Resources and Conservation, Water Resources Division, State of Montana, "Technical Assistance Program, Teton Cooperative Canal Company Report," January 1979.

4. U.S. Weather Bureau, Technical Paper 38, Generalized Estimates of Probable Maximum Precipitation for the United States West of the 105th Meridian, Washington, D.C., 1960.

APPENDIX

DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION
WATER RESOURCES DIVISION

THOMAS L. JUDGE, GOVERNOR
32 SOUTH EWING
STATE OF MONTANA
(406) 449-2872
HELENA, MONTANA 59601

September 19, 1980

Department of the Army
Seattle District, Corps of Engineers
P.O. Box C-3755
Seattle, WA 98124

Attn: Ralph Morrison

Re: CH2M/Hill Dam Safety Inspection Report on Eureka Reservoir Dam and Dikes, Main Dam(MT-1354) and West Dike (MT-1342)

Dear Ralph:

We have reviewed the above referenced final draft report. We concur with the findings and recommendations and find that it safisfies the criterial of the Phase I report.

Minor editorial comments have been discussed with your staff, and we understand these will be incorporated in the final report.

Thank you for this opportunity to review and comment on the final draft report on Eureka Reservoir Dam and Dikes.

Sincerely,

Richard L Bondy

Richard L. Bondy, P.E.
Chief, Engineering Bureau
Engineering Bureau
(406) 449-2864

RB/AT/lj

"AN EQUAL OPPORTUNITY EMPLOYER"

October 29, 1980

United States Army Corps of Engineers
Seattle District

Dear Sirs:

Enclosed is the board of directors comments on the recomendations as outlined in the final draft of the report on the Eureka reservoir dam and dike.

1. An alert system has been agreed upon and will be implemented as follows. The reservoir level is continually checked every 12 hours during high river flow and runoff. In case of emergency the ditch rider would radio the sheriffs office and civil defense authorities, which in turn would contact the city hall which would blow the fire siren a designated number of times and the ditch rider and sheriffs personal would notify people downstream.

2. This fall the gravel on the upstream side will be pushed back up to help prevent any errosion. This would help provide protection on the abutment contacts of the main dam as mentioned in number four.

3. Outlet conduit and wet well tower were inspected two years ago and is inspected whenever the reservoir is drained. It was found to be in good condition.

4. See No. 2.

5. The board feels that the brush and trees on the west dike Provides wind protection thus preventing any damage from high waves in windy conditions.

6. Whenever any condition arises to necessitate any spillway action, the main gate is opened and the waste gate in the canal downstream is opened ane the water dumped back into the river. This has always been done to control overfill and damage to the dam.

7. There is a keyway built into the dam foundation and filled with rock, designed to drain any interior water from the dam.

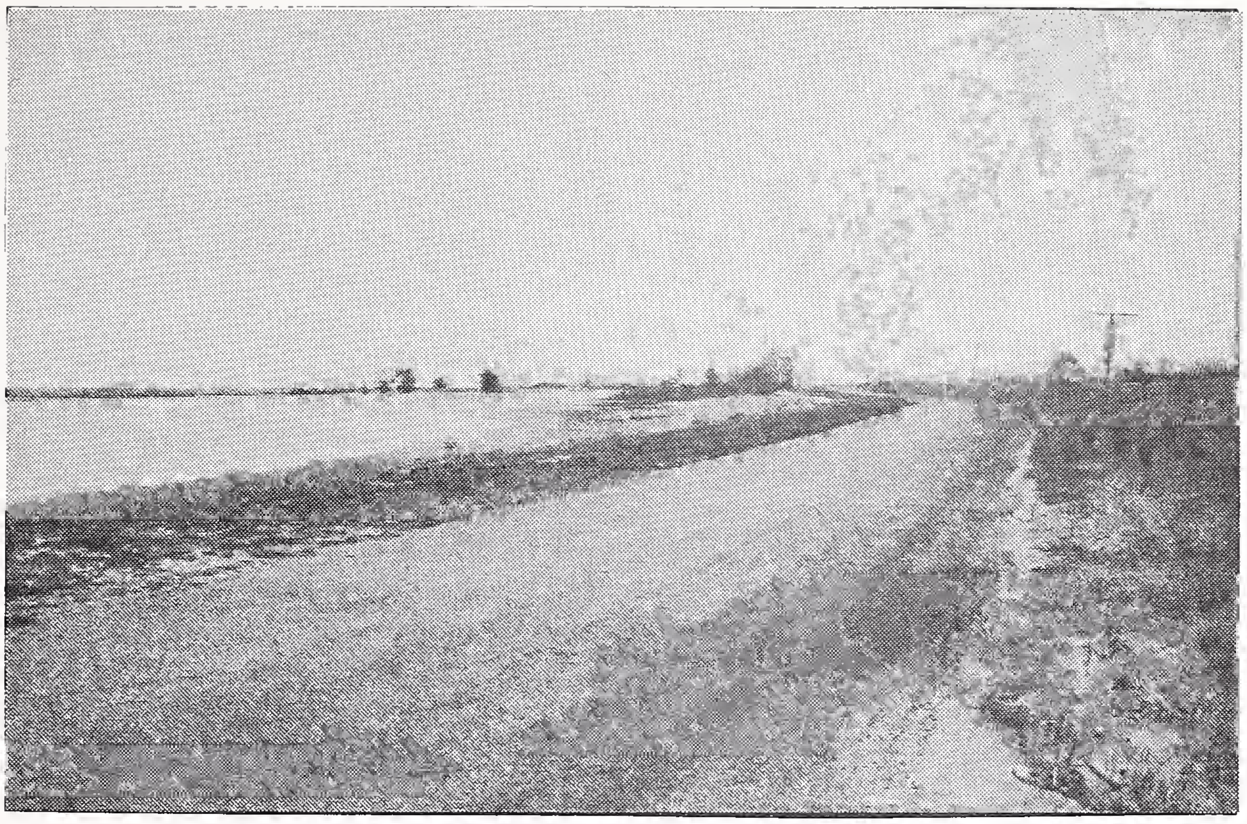
8. We, the board, feel this inspection should be done and your office is well qualified to conduct such an inspection.

Sincerely

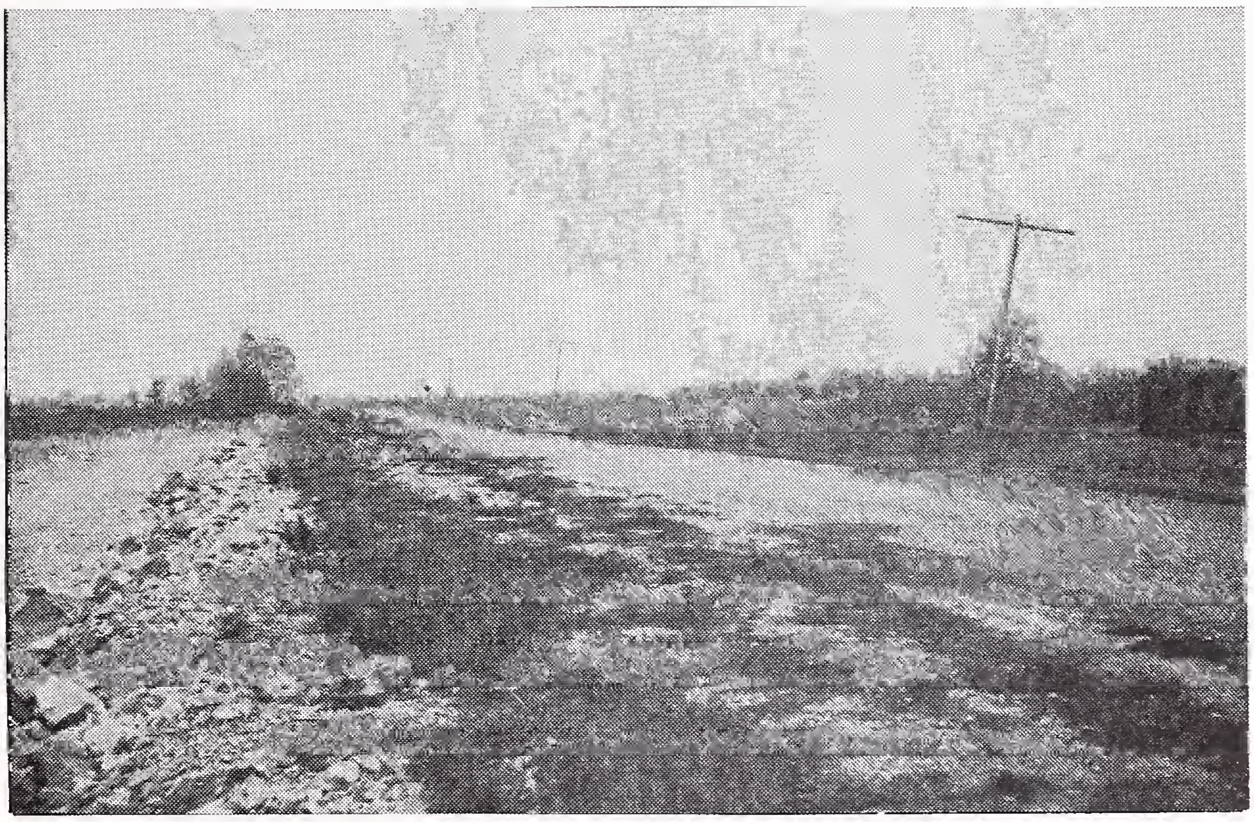
Teton CO-OP Canal Co.

James E. Carlson, Sec.

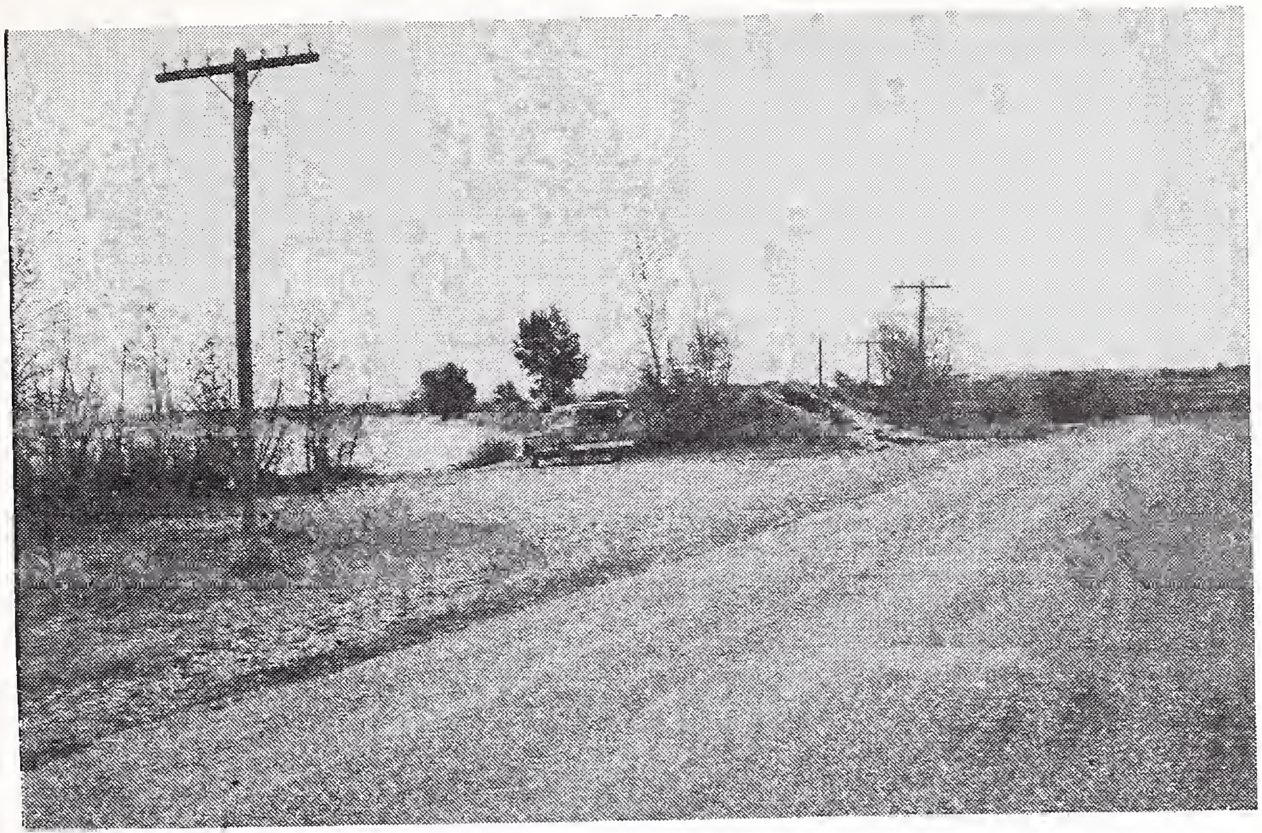
James E Carlson, Sec



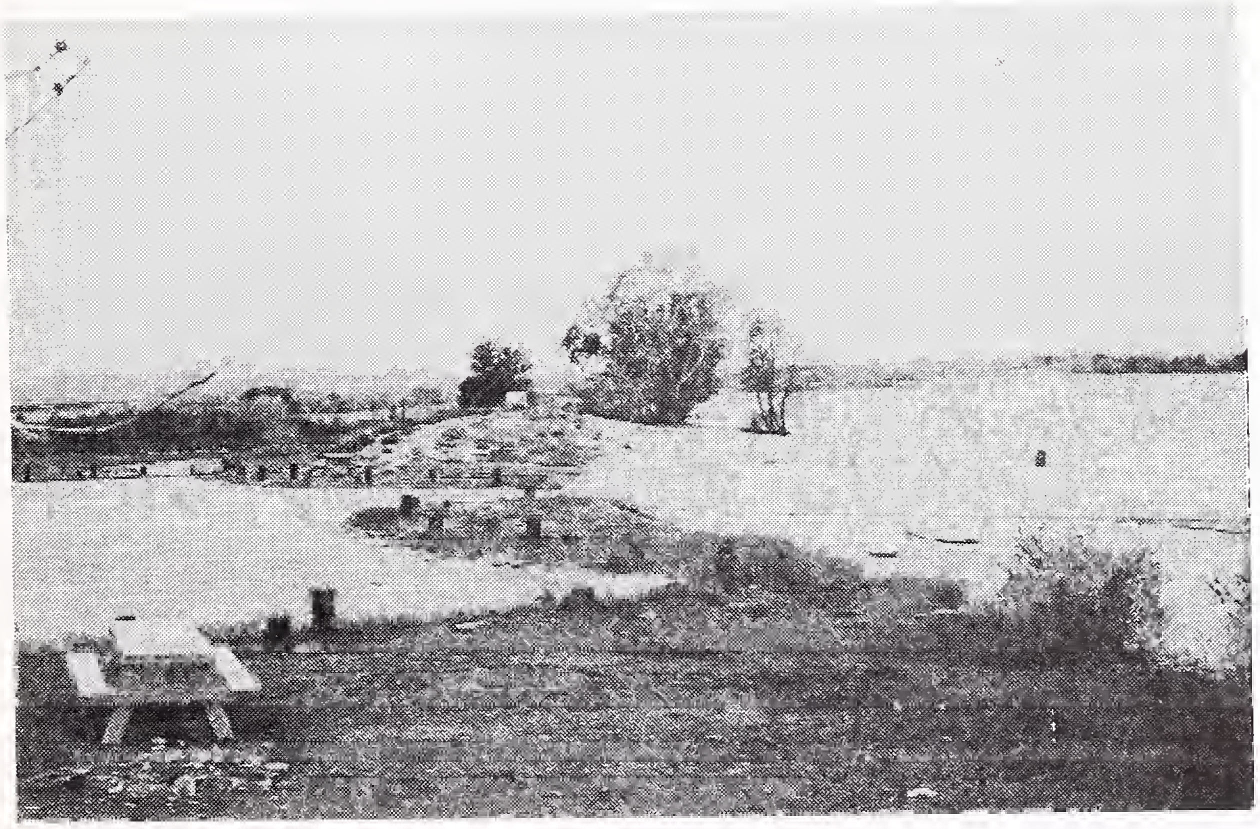
(PHOTO 1) OVERFLOW AREA AND ROADWAY WEST OF DAM



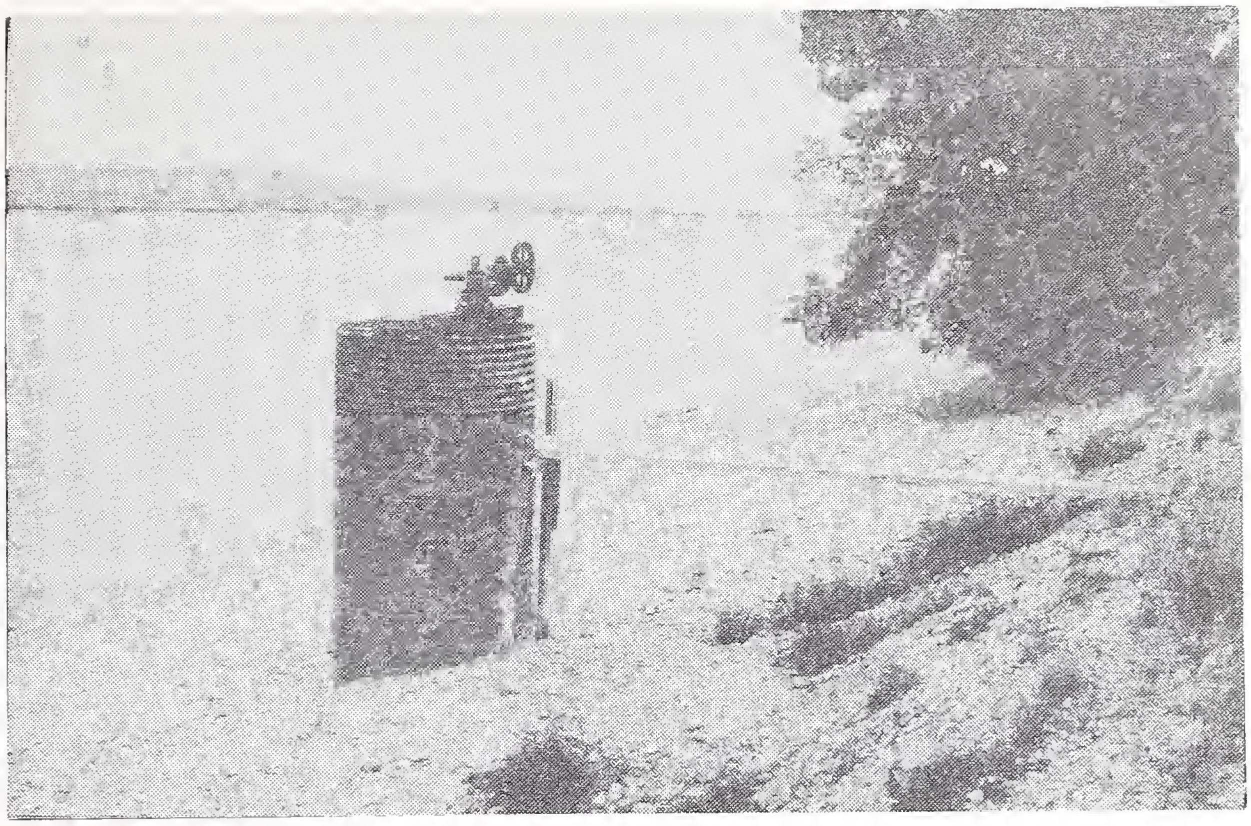
(PHOTO 2) OVERFLOW AREA, ROADWAY, RIPRAP PROTECTION, WEST OF DAM



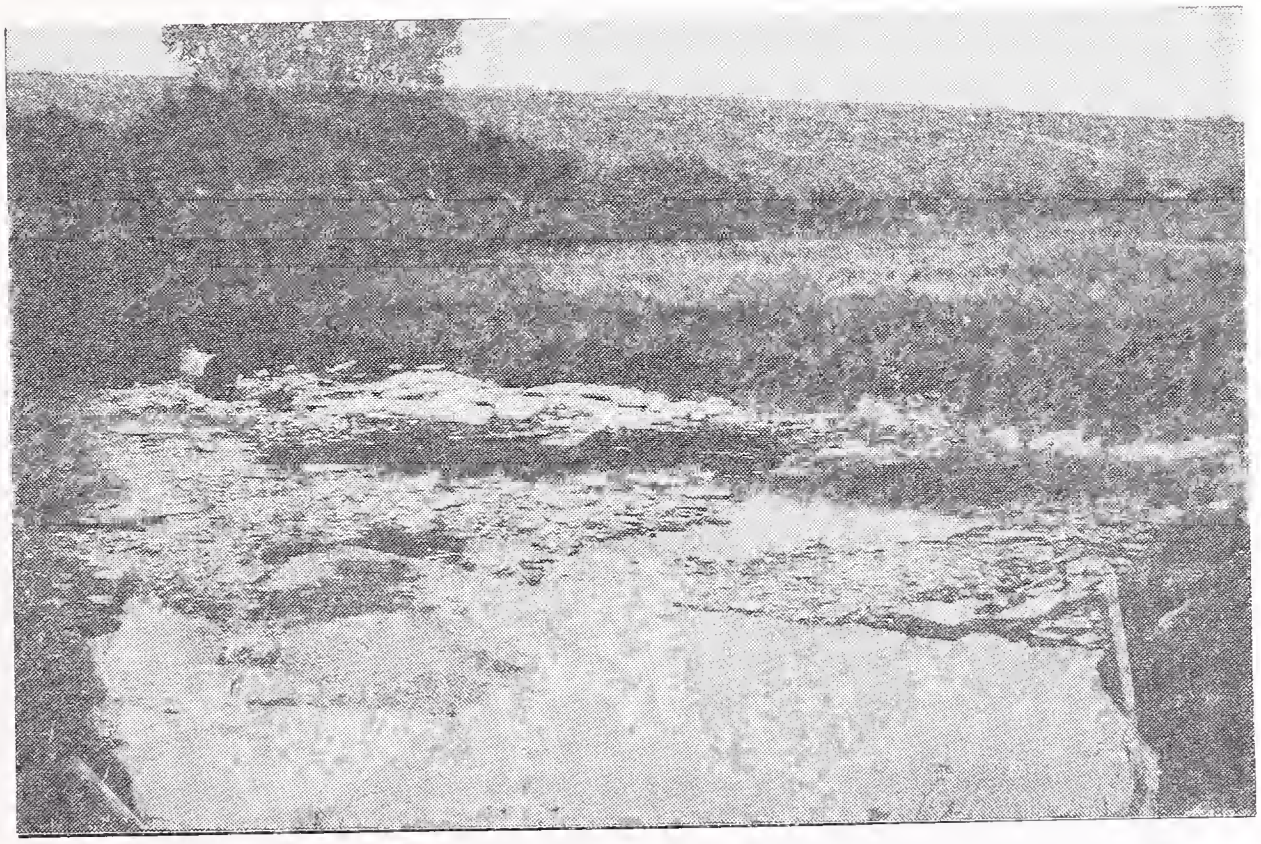
(PHOTO 3) WEST END (RIGHT ABUTMENT) OF DAM



(PHOTO 4) EAST END OF DAM AND OVERFLOW AREA.



(PHOTO 5) FIVE-FOOT-DIAMETER GATE OPERATING TOWER AND GRAVEL UPSTREAM SLOPE



(PHOTO 6) THREE-FOOT DIAMETER LOW LEVEL DISCHARGE CONDUIT AND DOWNSTREAM SLOPE

(PHOTO 7) DISCHARGE CONDUIT AND DOWNSTREAM SLOPE

(PHOTO 8) EAST DIKE, APPROXIMATELY 4 FEET HIGH, 400 FEET LONG

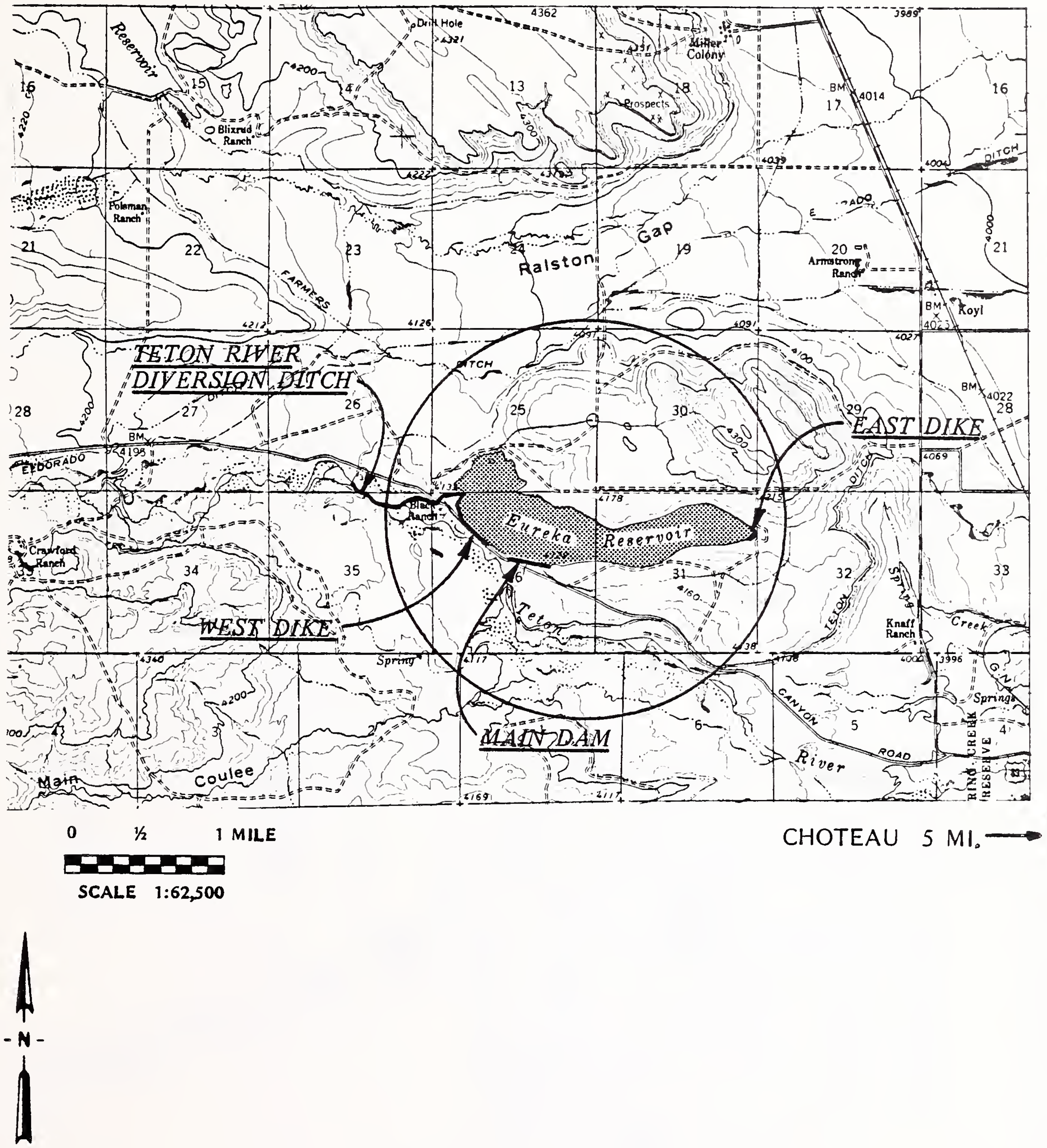


PLATE 1
EUREKA RESERVOIR DAM
VICINITY MAP

CH2M HILL

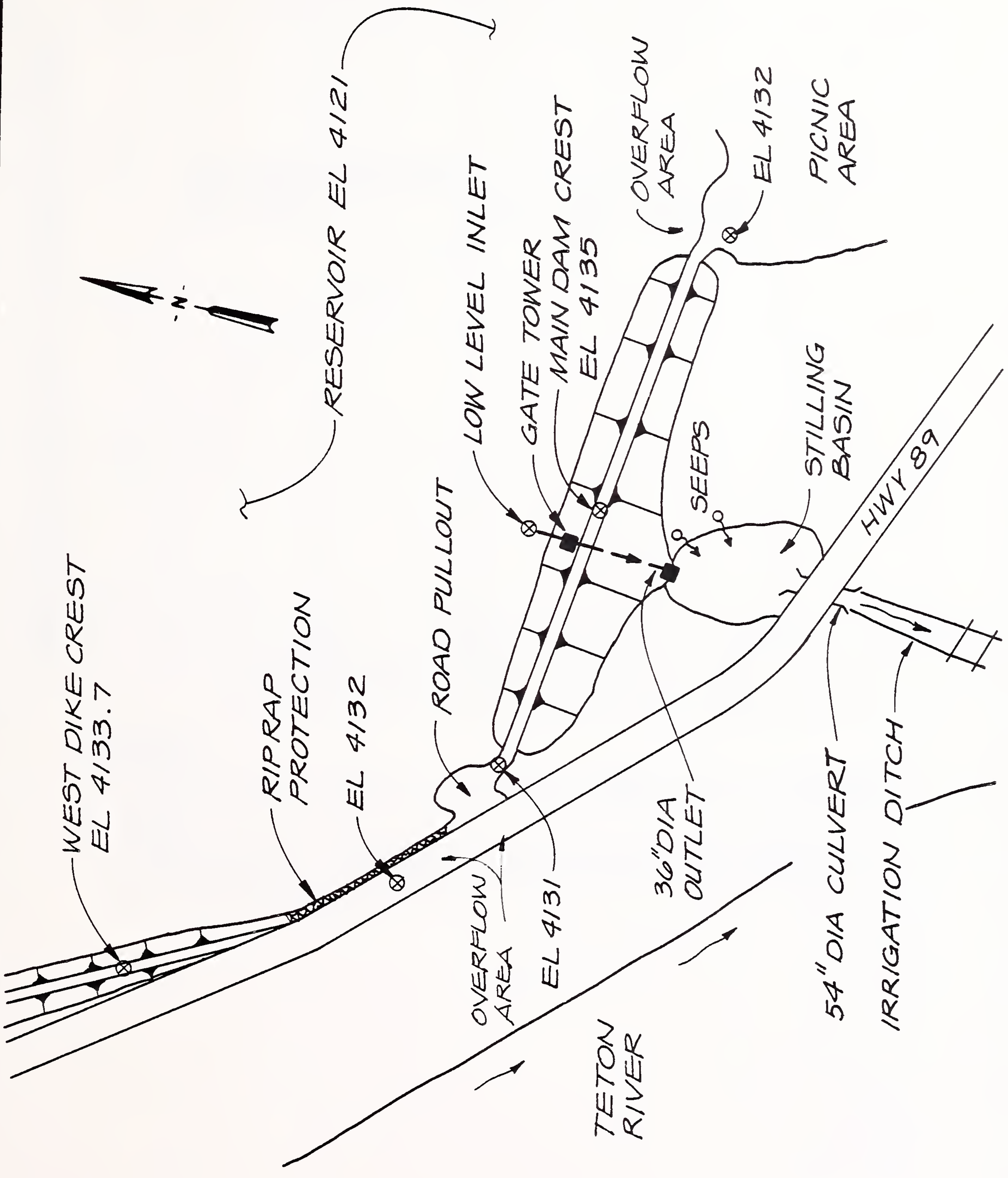
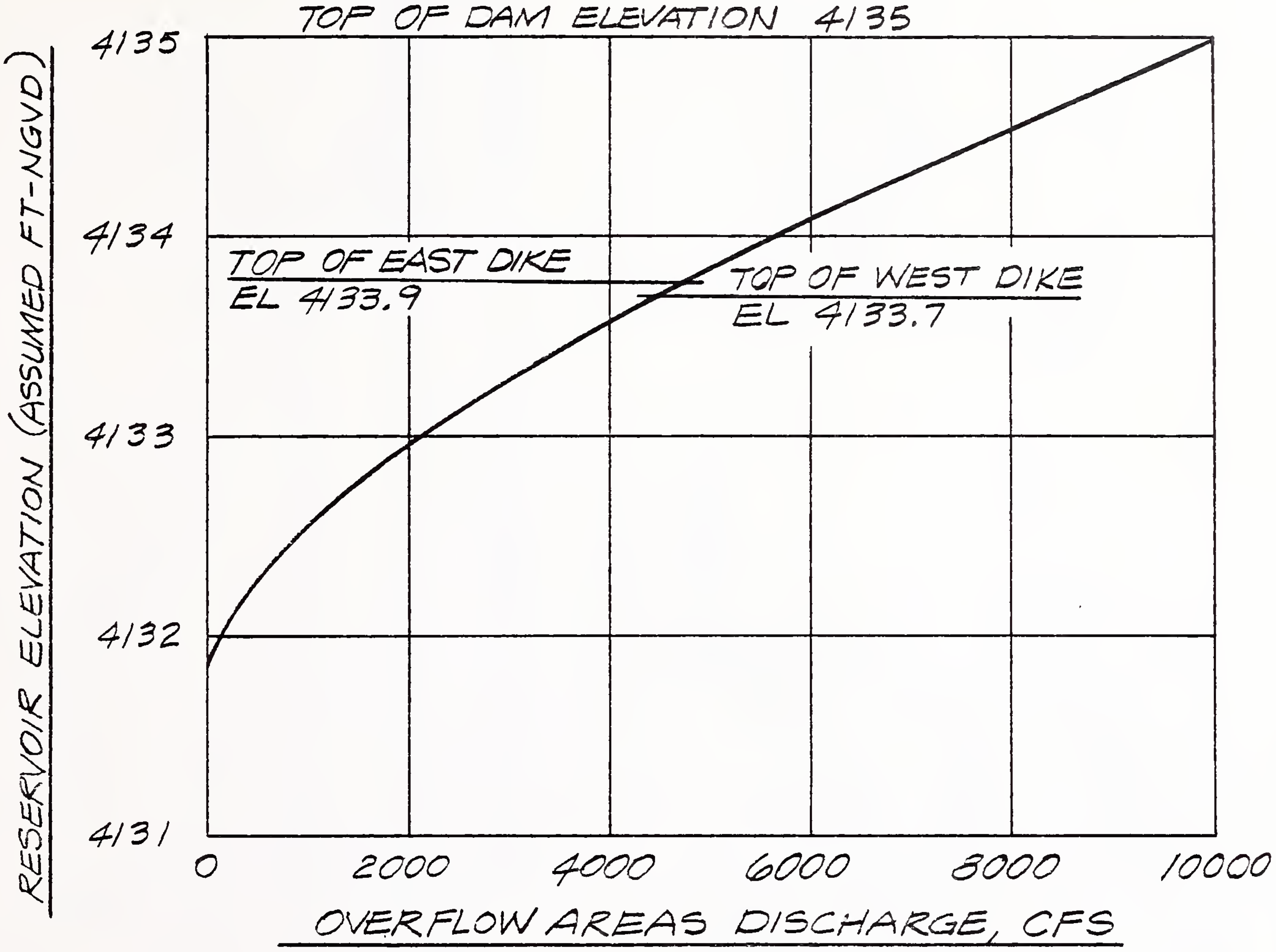


PLATE 2
EUREKA RESERVOIR DAM
MAIN DAM SITE PLAN

CH2M HILL

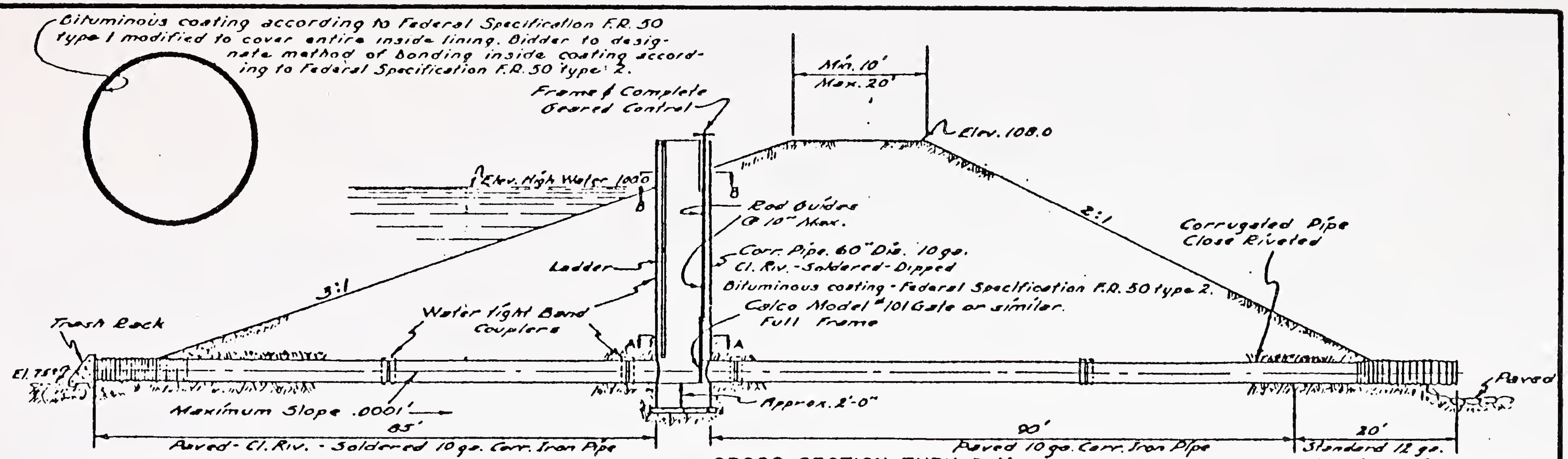


NOTES:

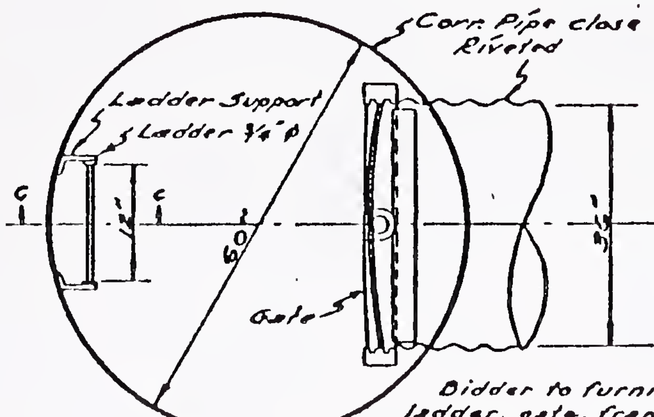
1. ESTIMATED RATING OF LOW AREAS AT EUREKA DAM.
2. ELEVATIONS ARE BASED ON AN ASSUMED ELEVATION 4135 FEET NGVD FOR THE CREST OF THE MAIN DAM.

PLATE 3
EUREKA RESERVOIR DAM
OVERFLOW AREAS
DISCHARGE RATING CURVE

CH2M HILL

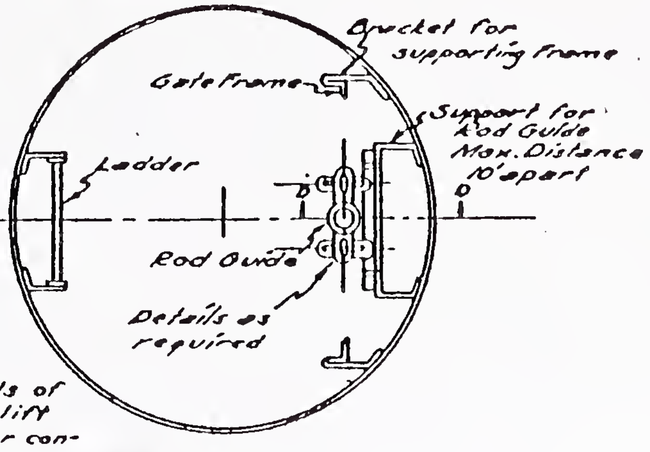

Bituminous coating according to Federal Specification F.R. 50 type 1 modified to cover entire inside lining. Bidder to designate method of bonding inside coating according to Federal Specification F.R. 50 type 2.
Frame & Complete Geared Control
Min. 10'
Max. 20'
Elev. 108.0
Elev. High Water 100.0
Rod Guides @ 10" Max.
Corr. Pipe. 60" Dia. 10 ga. Cl. Riv. - Soldered - Dipped
Bituminous coating - Federal Specification F.R. 50 type 2.
Calco Model #101 Gate or similar. Full Frame
Ladder
3:1
2:1
Corrugated Pipe Close Riveted
Trash Rack
Water Tight Band Couplers
El. 75.0
A
Maximum Slope .0001'
Approx. 2'-0"
Paved
85'
90'
20'
Paved - Cl. Riv. - Soldered 10 ga. Corr. Iron Pipe
Paved 10 ga. Corr. Iron Pipe
Standard 12 ga. Corr. Iron Pipe

CROSS SECTION THRU DAM

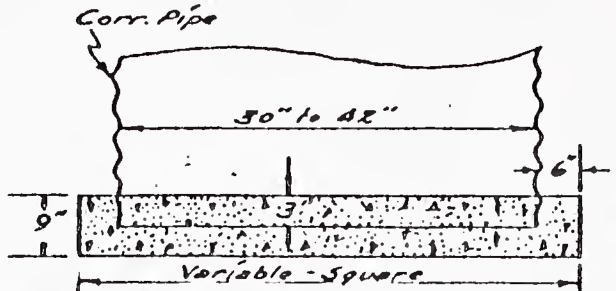


Bidder to furnish details of ladder, gate, frame, gate lift and stem to operate under conditions shown.

SECTION A-A

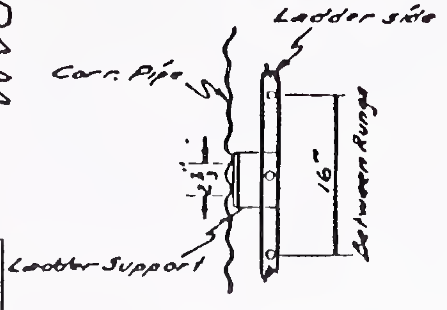

Bracket for supporting frame
Gate Frame
Support for Rod Guide Max. Distance 10' apart
Ladder
D
D
Rod Guide
Details as required

SECTION B-B



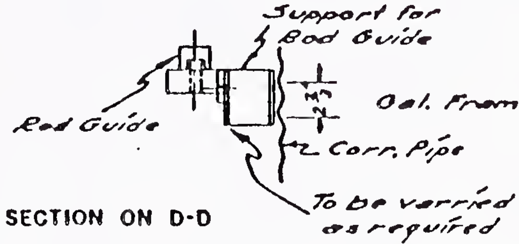
CONCRETE BOTTOM FOR STANDPIPE

1:2:4 MIX



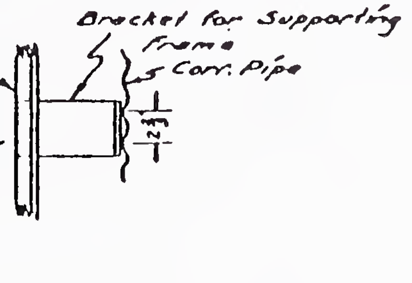
SECTION ON C-C

DETAIL - SUPPORTING LADDER



SECTION ON D-D

DETAIL - SUPPORTING ROD GUIDE



SECTION D-D

DETAIL - SUPPORTING GATE FRAME

NOTE :
THIS PLATE TAKEN FROM
DRAWING 2-FFF-40

PLATE 4

EUREKA RESERVOIR DAM OUTLET WORKS AND EMBANKMENT SECTION

CH2M HILL